other hand, if soft pure water be the only safe supply, that its substitution may be hastened with the utmost rapidity, or means at once resorted to for the palliation or prevention of mischief, not merely future, but at this moment, in active force.

For our own part we cannot bring this grave question again under consideration more effectually than by citing the conflicting, or at least apparently conflicting, evidence, *pro* and *con*, leaving it especially to those professional chemical authorities who seem to be at variance, to come to a right understanding, and hence to unanimity, on the subject, as best they may.

And, first, in support of the assertion that danger is not to be feared from soft water, but from hard. In favour of this view, a view which we hope will be found correct, although we confess that our fears are still at loggerheads with our hopes, the most influential evidence we have yet seen is that of Dr. Lyon Playfair. On the 6th ulto. we inserted in our columns a report of a lecture by this gentlemen at the Museum of Practical Geology, on water-supply, from which we quote the following passage:—

"It has been asserted that *soft water* acts injuriously upon lead; and that the presence of lead can be detected in soft water which has been kept in leaden cisterns by the addition of sulphate of ammonia. This latter is a delicate test for lead, throwing it down in a faint bluish precipitate. In order to test the truth of this assertion, Dr Playfair had prepared a number of bottles, each containing a piece of lead immersed in water containing specimens of all the salts found in the London water, and also in water free from these salts, or perfectly soft. These bottles were sealed up in January last, and the action of all the water containing salts was very apparent, while the soft water had not acted on the lead at all. As an example of those which had no action on the lead, the lecturer specially alluded to the Wandle water, one of those proposed to be brought into London, and well known for its remarkable softness. Where common salt is present in water, the action on lead is considerable. *All his experiments tend to prove that perfectly soft water has no action on lead, and that all the solid ingredients of water* [constituting *hard water*] *tend to produce and increase the action of lead.*"

Before proceeding to quote any other evidence, we must here remark, that so far as regards Dr. Playfair's experiments with perfectly soft water, the plain inference which the public must inevitably draw from a set of experiments so exhibited at such a time, is, that it is perfectly safe to pass pure soft water through leaden pipes, and to keep it in leaden cisterns. This, we have no doubt, is the lecturer's own conclusion; but it is necessary to point attention to it, in order to remark that, while there is a singular coincidence, in *fact*, between the result of such experiments, and the assertion of Dr. Paris, in his Treatise on Medical Jurisprudence, that "pure water, *provided the air be excluded*, does not appear to exert any sensible action upon lead," and of Christison, in his Treatise on Poisons, that "distilled water (that is, chemically *pure* and soft water), *deprived of its gases by ebullition, and excluded from contact with the air*, has no action whatever on lead;" still there is a mighty difference indeed, as will be afterwards clearly shown, in ultimate results.

Dr. Playfair's conclusion appears to be supported by practical evidence. Thus, in the appendices to "The Report on the Supply of Water to the Metropolis," issued by the General Board of Health, and already quoted at p. 169 of vol. ix. of our journal, a working plumber, William Millard, gives the following evidence:—

"What is your observation of the different action of hard and soft water on leaden cisterns?—The hard water eats the cistern away: the soft water (that is, rain water) does not sensibly touch it at all. The hard water of Highgate will, in a few years, eat the bottom of a leaden cistern entirely away, so that it will be useless.

In how many years?—In about three or four years.

Does not a leaden cistern usually last longer than that in Highgate?—No; it eats holes in the bottoms, particularly at the places where there is solder, giving it a honey-combed appearance. This is so much the case, that it is a common custom here for the people to have their cisterns painted.

Is that a protection?—Yes, if the paint be allowed time to get thoroughly dry before the water is let into the cistern, the water does not act upon dry lead; and the cisterns will then last for years."

This evidence, we say, *appears* to support that already adduced. As to the safety of soft water, it decidedly does so; but it may be a question, whether it really were the hard water itself that here was in fault, so much as the galvanic action of the solder, and some intermittent exposure to air while moist, from want of constant supply, and of consequent quiet and continued deposition of protective crust.*

That other practical men, however, have come to a like conclusion, so far as regards the influence of hard water, appears from the evidence of Mr. Spencer, of Liverpool (the discoverer of the electrotype, if we mistake not, and, hence a most competent authority). He says,—

"Those who have observed the destructive effects of hard water on cisterns, especially in Liverpool, where the water is pre-eminently hard, but who have not studied the matter chemically, have been at a loss to account for some of the scientific opinions so much at variance with their daily observation. In a word, the closet experimenter has usually come to the conclusion, that *soft water only* acts upon lead, while the practical observer finds that cisterns are more rapidly corroded by hard water; hence has arisen so much conflicting opinion. A little reflection, however, will render it obvious that the effects of practice can scarcely be observed by the mere immersion of slips of bright lead into glass vessels containing either hard or soft water; and there suffering them to remain for a few weeks, perhaps only so far covered as to prevent evaporation or the accession of dust.

It must be recollected, also that, as cisterns are constructed, lead is not the only metal which has to be dealt with; there being the solder which is used for the joints. Now this substance, which is an admixture of lead and tin, will, when immersed in water along with lead, act as a distinct metal, and give rise to a voltaic action between the lead, the solder, and the water. This will cause a rapid corrosion at the joints, but it will be more or less active *in proportion to the hardness or chemical impurity of the water*."

Here, indeed, the evidence is not only in favour of Dr. Playfair's experiments and conclusions in some respects, but in others something more: in fact, it strikes both ways, and increases the critical interest of the question.

Dr. R. Angus, in the following evidence, also corroborates the truth of the idea that hard water is dangerous in lead, while at the same time, however, asserting that soft water is still more so:—

"The use of lead pipes is common enough; and although the danger from lead has often been pointed out, there is no diminution in the amount used. It is acknowledged that with soft water lead is very dangerous; but I am disposed to think that it is dangerous even with hard, except when a crust forms upon it. When a lead-pump is used, no matter how hard the water is, there is still lead to be found in it. In one case I found lead where there were 62 grains of lime salts in a gallon: the family filtered the water, but that did not quite remove it, although it was much improved. This shows the lead to have been in complete solution although the water was hard. The pump was made of lead, so that there was a constant friction preserving the surface clean and assisting combination."

Here, however, it is obvious that the hard water had no opportunity of forming the protective crust, so that this evidence rather militates in favour of the comparative safety of hard water in lead cisterns, explaining, by inference, why it is so, as well as one way in which it may nevertheless be dangerous to use either hard or soft water, viz. in association with a leaden pump.

Again: we find a correspondent of our own, Mr. H. Osborn, of Southampton, a practical chemist, while corroborating the truth of some previous remarks by us on the mutual influence of lead and water, stating that he

"Examined some water a few months since, which contained lead in solution, and the pipe had been laid down about fifteen years; but, notwithstanding that the solid contents contained in a pint of the water amounted to ten grains, and were composed of chlorides and sulphates, *they afforded no protection by forming an insoluble crust*, otherwise the lead would not have been found in solution."

It so happens that Mr. Osborn also makes some remarks on experiments with slips of lead in glasses of water, which not only corroborate the truth of Dr. Playfair's experiments, but, in fact, seem to show how they may be reconciled with the opposite conclusion. We shall quote them here, although they might, with equal propriety (perhaps even greater), have been reserved to strengthen the adverse view:—

"There is less danger in drinking water when kept in leaden tanks, than when it has passed through pipes, because the gases which usually form the most soluble corrosive matter are confined within the pipe, whereas, in open cisterns, the gas is more liable to escape. I have found carbonic acid in water which corroded lead rapidly when corked up in a bottle or confined in a pipe (the pipe leading from the pump to the well is of course always full of water), but when a slip of lead is introduced into a glass of the same water, the metal is scarcely acted upon, owing to the gas escaping."

NOTES IN THE PROVINCES.

Windsor.—The Castle approaches seem to make but slow progress towards completion. "A fresh difficulty," says the *Windsor Express*, "has arisen with respect to the boundary of the fence at the turning into High-street. The line was laid out in conformity with the directions of his Royal Highness Prince Albert, and so perfectly satisfied were the authorities of the town with it, that they resolved to erect a handsome pedestal lamp in the centre of the opening caused by the junction of High-street, Castle-street, and Peascod-street. Much to the surprise and disappointment of the inhabitants the curve of the pavement has again been altered so as to encroach six feet more into the carriage way, and thus render the erection of a large public lamp at the junction entirely out of the question. The Mayor and Mr. Bedborough have been re-appointed to arrange the matter with the Commissioners of Woods and Forests," who appear to be considered as exclusively responsible for the alteration made.

Portsmouth.—Messrs. Fox and Henderson, who have the Government contract for the erection of a new smithy in Portsmouth yard, have commenced their work. The old buildings have been cleared away. The smithy will stand between the new factory and the building slips, and will take in Nasmith's patent steam hammer. The *Hampshire Guardian* says "it is to be constructed of glass and iron, and a part of the late building in Hyde-park will, in all probability, form the structure."

Portland.—The break-water works are making progress, and already afford shelter to shipping. The works are carried out to a distance of 7,750 feet from the original line of shore into about nine and a quarter fathoms of water. Notwithstanding the damage done on 1st October last, when upwards of 300 feet of the

* To be continued.

* A witness from Paisley, where soft water has been introduced, says that corrosion in pipes takes place only under the intermittent supply, by the action of the atmosphere on the pipe in a damp state; and that an iron pipe constantly charged will not corrode at all, whether the water be hard or soft; and will last at least four times as long as a pipe where the air is admitted into it. Other witnesses corroborate the fact that, with some waters, the wear of pipes by the intermittent supplies is frequently very rapid, the ratio as to being, that corrosion takes place whilst the pipe is empty, and that the oxide is swept away by the return of the water. As to galvanic action, Christison, in his treatise on Poisons, ed. 1848, p. 536, says,—"I have seen pipes deeply corroded externally, when made of sheets of lead rolled and soldered; and the action was deepest on each side of the solder, which had itself entirely escaped corrosion. *Even inequalities in the composition of the lead may have the same effect.* Sheet lead, long exposed to air or water, is sometimes observed to be corroded in particular spots, and these will always be found in the neighbourhood of parts of the metal differing in colour, hardness, or texture from the general mass." Similar effects, he remarks, may arise simply from fragments of other metals lying along in contact with the lead. They may also, he thinks, arise even from portions of mortar being allowed to lie on the lead; but the action here, of course, is not galvanic. He has no doubt that many of the instances of unusually rapid corrosion of lead by water are really owing, not to the simple action of the water, but to an action excited, obscurely, in one or other of the ways now mentioned.

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